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Clinical pathways in China – an evaluation

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Structured Abstract:
Purpose: Clinical pathways are multidisciplinary care plans with essential care steps for patients with specific clinical problems. Clinical pathways were introduced in China in 2009 to assure quality, reduce risks, increase efficiency in resource use and control costs. We present a Chinese public hospital case study where a clinical pathway pilot was undertaken where we evaluate two main outcomes: stay and hospitalization costs for a tertiary hospital from 2010 to 2012 using a mixed methods approach.
Design/Methodology/Approach: Data were drawn from hospital records and in-depth interviews with hospital staff in a Shanxi Province tertiary hospital, northern China.
Findings: We found that the main objectives: to standardize treatment procedures by reducing stay and containing costs, were not fully achieved. Staff implementing clinical pathways clearly encountered several institutional barriers; i.e., managers did not see the pilot as a useful managerial instrument driven by revenue generation. Physicians, too, lacked incentive to follow the guidelines due to income concerns.
Practical implications: We point to the daunting challenges brought about by perverse incentives embedded in the country's health system. We argue that concerted efforts are needed to undertake difficult health policy reforms in China.
Originality/value: We present the first empirical study in the English-language literature that examines China's ongoing clinical pathway pilots from a micro perspective. We combine qualitative and quantitative methods and reveal the hospital-level dynamics in its implementation.

Keywords: Clinical pathways, Care quality, Cost containment, China.

Article Classification: Research

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Introduction

China's deteriorating health system in the past three decades is well-known to the health policy research community. The *laissez-faire* policies adopted during the market transition detrimentally affected residents' access to affordable care (Blumenthal and Hsiao, 2005).

Several misaligned incentives created during the market reforms transformed a centrally-planned health system that provided cost-effective care to one plagued by rapid cost inflation and heavy out-of-pocket burdens (Ma *et al*., 2008). In response to major public dissatisfaction, the Chinese government launched its national healthcare reform in 2009, vowing to overhaul the country's ailing health system. One prominent ongoing initiative is the clinical pathway (CP) system, which is believed to be instrumental to both quality improvement and cost containment. Launched in December 2009 on a pilot basis, it is now implemented in 5,924 public hospitals, with more than 400 diseases included in the program. The government requires all Class III (tertiary) hospital and 80% Class II (secondary) hospital staff to participate in the CP program by 2015. More specialties and diseases are to be included (Ministry of Health, 2012).

Clinical pathways (care pathways, integrated care pathways and care maps) are multidisciplinary care plans that detail essential care steps for patients with specific clinical problems (Rotter *et al*., 2010). Informed by evidence-based medicine, CPs identify appropriate clinical interventions, timeframes, milestones and expected outcomes for homogenous patient groups (Queensland Health Clinical Pathways Board, 2002). Since their first introduction in 1985 at the US New England Medical Center, CPs are mainly used as a framework for balancing costs and quality in response to escalating healthcare costs. Winning popularity in the past three decades, CPs became internationally accepted in almost all healthcare management models (Hindle and Yazbeck, 2005). For instance, more than 80% of staff in US hospitals use CPs for at least some interventions (Saint *et al*., 2003).

By standardizing care provision, CPs improve care quality, reduce risks, increase efficiency and control costs (de Bleser *et al*., 2006). In particular, length of stay (LoS) and hospitalization costs are two main indicators used to assess CP program outcomes. Previous studies report a significant reduction in hip and knee arthroplasty LoS and for treating fractured neck of femur, asthma, atrial fibrillation pneumonia, chest pain, etc. In relation to decreasing LoS, costs were also substantially reduced after CPs were introduced (Choong *et al*., 2000; Dowsey *et al*., 1999; Feagan, 2000; Johnson *et al*., 2000; Kim *et al*., 2002). Meantime, CPs also produced positive effects on patient outcomes, measured by hospital readmission rate, complications, in-hospital mortality and other major indicators (Rotter *at al*., 2010). Encouraged by the CP program's remarkable performance elsewhere, the Chinese government see as a promising tool to contain the country's rapid cost escalation while improving care quality.

We present a Chinese public hospital case study where a CP pilot was undertaken. We evaluate two main outcomes: LoS and hospitalization costs for a tertiary hospital in northern China from 2010 to 2012 by using a mixed methods approach. Data were drawn from patient records and in-depth interviews with hospital staff. CP success depends on traditional factors such as qualifications, competencies, program design and many institutional factors, especially incentives to shape physician prescribing behaviors. We investigate a less successful case in China, which demonstrates how a CP program was implemented in an environment not conducive to cost containment and demonstrates actual results. We point out the daunting challenges brought about by the perverse incentives embedded in the country's health system for decades. It is argued that concerted efforts are needed to undertake difficult health policy reforms in China.

China's health policy reforms and the CP pilot

China's health system, which changed from an excellent model set up by the World Health Organization and the World Bank for developing countries, to one ranked at the bottom is dramatic and well-known. Before its market transition in the late 1970s, the Chinese health system was embedded in a large communist economy institutional framework under which a

three-tiered public system provided highly subsidized services (Gu, 2001). The public delivery system financed by basic health insurance schemes produced internationally revered outcomes and offered the world a model for providing basic but effective care at fairly low costs (Blumenthal and Hsiao, 2005). The market transition, however, has dramatically undermined the old system's economic and institutional foundation since the 1980s. After government revenues declined from 1980, the central government had to substantially limit its funding to the health sector; accounting for 50 to 60% of hospital income under the planned economy (Hsiao, 1995). Unable to finance public hospitals, the government instead allowed managers to generate income from user fees for financial survival, encouraged by an ill-designed fee schedule, which has created high-powered incentives for hospital staff to shift from cost-effective care to over-utilizing high-tech diagnostic tests and expensive pharmaceuticals, powerfully inflating the costs (Liu *et al*., 2000). Fully motivated to generate profits, most managers tied physician incomes to revenue generation, which added one more perverse incentive that favors profit-making while ignoring patient care (Liu and Mills, 2003). Overusing high-tech tests and drugs over-prescribing are ubiquitous in Chinese hospitals run as profit-seeking entities (Yip and Hsiao, 2008) and it is estimated that 20 to 30% of China's total health expenditure is spent on unnecessary care (Zhong, 2001).

Patient sovereignty was further affected by deteriorating financial protection mechanisms. Old insurance schemes have either been dismantled or weakened following structural changes in urban and rural economies (Gao *et al*., 2001). Citizens covered by health insurance schemes saw a steep drop in the 1990s and the early 2000s and simultaneously, out-of-pocket payments rose rapidly. Poor insurance coverage, coupled with misaligned supply side perverse incentives drastically transformed China's healthcare landscape. Health expenditure is escalating at a double-digit rate while expensive access to care (*kanbing nan*) and medical impoverishment (*kanbing gui*) top public concerns and have sparked widespread public outrage. To safeguard social stability and build a professed harmonious society, the central government finally demonstrated an unprecedented political will and embarked on a holistic healthcare reform program in 2009. Through this landmark reform, the government vows to overhaul a deteriorating system and build a universal replacement by 2020. In particular, top on the reform agenda is containing skyrocketing cost and alleviate the vast public discontent about affordability (He, 2011). However, cost containment, as witnessed elsewhere, is a formidable task for health policy makers, compounded by highly concentrated numerous hard interests and the system's path dependence.

While the government understands that effective healthcare cost containment ultimately depends on systemic reforms that will take a much longer time to take effect, some intermediary measures are critically needed to ease the policy gridlock. The CP program is a prominent initiative. Since 2009, CPs have been executed as pilots, steered by the Ministry of Health (MoH).This program is expected to standardize care provision and thus improve service quality and pave the way for alternative payment methods, especially diagnosis-related groups (DRGs) (He, 2011). All public hospitals participating in the pilot are required to set up executive and assessment committees to facilitate implementation. The MoH issued both guidelines and work manuals, and hospital staff are asked to start with common diseases before expanding the list (MoH, 2013). The diseases to be selected should be common and simple ones less prone to complications.

Figure 1 exhibits a pilot program CP flowchart. Deciding to enter a pathway or not is made by the initial diagnosis, operational need and special conditions. The medical team may choose not to enter a CP and opt instead for an ordinary treatment protocol. The major threat to a smooth pathway flow is variation; i.e., any major complication may make the pathway plan unable to deal with complicated conditions and thus clinical judgment is needed to

determine if the CP should be terminated or continued after modification. According to MoH staff, the average exit rate in all pilot hospitals is 9.7% while the completion rate is 84.2%, with the variation rate at 23.9%. Variations and misdiagnoses have been major reasons for exiting pathways (Zhao *et al*., 2013).

Figure 1 here

To understand the pilot program outcomes, the authors collected all empirical studies that evaluated clinical pathway implementation published after 2009. The authors accessed studies through major academic journal databases, namely the China Knowledge Resource Integrated Database (CNKI) and the Wanfang Data (Table I). The CP program has been tried with several major diseases. Most studies used a before-after or comparison group-control group design to examine CP effects. The inpatient sample sizes ranged from 60 to 2,881. All studies reported a marked reduction in LoS and inpatient costs. In the studies that breakdown expenditures, drug cost reduction was the most remarkable, suggesting the CP's positive cost-control effects. A nationwide assessment in CP pilot hospitals between 2010 and 2011 indicated that 90% of patients with diseases that were included in the experiment experienced reduced LoS while the average costs dropped accordingly (Jiao *et al*., 2013). The medical quality and outcomes were maintained (Zhao *et al*., 2013).

Table I here

While previous studies built a picture about CP effect on health expenditures, there are two main weaknesses. First, it is unclear whether this particular initiative led to significant cost containment for patients. Assessing LoS and hospital costs in general have not been as strong as might be desired. Some studies offer descriptive analyses by looking at the average health expenditures or cost increases before and after CP implementation, but more rigorous methods, such as modeling individual-level data using multivariate regression analyses, are needed to isolate or control other factors that may have influenced health costs other than CPs. Second, the recent literature offers little micro-level insights into how CPs are implemented in Chinese hospitals where perverse hard incentives intertwine and how the implementation process affects the pilot outcomes. Studies found that cost containment reforms tend to encounter several opportunistic responses from related parties, especially providers and these behaviors in turn may distort reform outcomes (He and Qian, 2013; Yang and Wu, 2014). It is therefore crucial to understand hospital dynamics by unraveling the incentives involved in CP implementation.

Methodology

A mixed-methods approach was employed to investigate a Shanxi Province public hospital CP pilot. Located in northern China, Shanxi is in the central economic belt that falls into the middle socioeconomic development strata. Hospital A is located in Taiyuan City, the provincial capital. Founded in 1952, hospital A is a major medical institution providing a comprehensive service. It has 1,800 beds and staffed by more than 700 health professionals. Affiliated with the Shanxi Medical University, it is a major teaching hospital and designated major social health insurance scheme facility. In 2013, Hospital A had 31,500 inpatient admissions and 546,000 outpatient visits. To understand CP effects and its implementation, quantitative and qualitative methods were employed. We used patient-level data to analyze CP effects from 2010 (the year when the pilot started in this hospital) to 2012 (the year it was fully implemented). Twelve interviews - four in February 2013 and eight in March 2014 - were also conducted. Administrative staff and physicians were interviewed to understand the

implementation process and the hospital's internal dynamics. Hospital A was chosen mainly because data were available. China's sheer size and wide regional disparity make single case studies virtually impossible to be wholly representative. It is not our intention to generalize the findings to the whole country; instead, we attempt to provide a micro account about implementing difficult cost containment initiatives in China's ongoing national healthcare reform and to explain the hospital-level dynamics against macro configuring incentives in the Chinese hospital system.

Quantitative analysis

Our quantitative data were collected from the hospital's administrative archive with prior consent. Constrained by availability, we chose the control group-comparison group posttest-only design to examine CP effect in Hospital A. All hospitalization records from 2010 to 2012 were collected. The dataset contains key variables concerning inpatient stay, including LOS, diagnosis, clinical tests, procedures and category costs. Inpatient stays in the CP pilot and those patients not involved were grouped respectively and formed our sample (Table II).

Table II here

Our dependent variables are LoS, total, drug and examination costs, and costs per day. The LoS is the inpatient days a patient experiences; total costs are measured as the aggregated formal medical costs incurred during hospitalization; drug and examination costs are measured as aggregated costs per inpatient stay; and costs per day are measured by the total costs divided by LoS. Our model considered factors that may influence inpatient utilization and costs. As commonly suggested and used in the health economics literature, this included both need and non-need sample population variables (Hernandez-Quevedo and Rubio, 2009; Gravelle *et al*., 2006; Jones, 2007). For need variables, we controlled age and gender. For non-need factors, we controlled job and marital status, and year. We employed two main quantitative strategies. Descriptive analysis was used to detect the annual LoS changes, total, drug, examination costs and costs per day from 2010 to 2012. To compare and estimate the changes in the utilization and costs for inpatient care for both the CP and non-CP patients, pooled data from 2010 to 2012 were subjected to regression models commonly used in the health economics literature (Gravelle *et al*., 2006, Jones, 2007, O'Donnell *et al*., 2008). Regression analyses were conducted for CP and non-CP diagnoses, respectively, to detect annual utilization and cost changes, controlling for any individual characteristics. Specifically, the discrete non-negative count dependent variable: LOS, distribution demand particular estimators. The most basic approach is to assume a Poisson process to describe the probability of observing inpatient stay y_i, conditional on explanatory variables, X_i (age, gender, job status and year):

$$(1)\quad \Pr(y_i \mid X_i) = \exp(-\lambda_i)\lambda_i^{y_i} / y_i!$$

where exp () is the exponential function, y_i! indicates y_i fractional, and λ_i is the conditional mean of the count and is usually specified as:

$$(2)\quad \lambda_i = E[y_i \mid X_i] = \exp(X_i\beta)$$

A Negative Binomial/Negbin estimation was also given in the analysis. The estimation maintains the Poisson process for Equation (1) but extends Equation (2) to include an error term, for which a (gamma) distribution was assumed. Finally, the health cost variables log

(i.e., drug, examination, total and costs per day), were modeled using the ordinary least square (OLS) regression as follows:

$$(3)\ Z_i = \alpha + \sum_j \beta_j X_{ji} + \varepsilon_i$$

Where X_j is the explanatory need and non-need variables, α and β are the parameter vectors, and ε is the residual. For all analyses, the Variance Inflation Factor computation was performed and the results indicated that multicollinearity was not a problem. Ramsy RESET tests were also performed and the results showed that the models had no specification problems.

Qualitative analysis

Two interview rounds were performed; the first in February 2013 - four semi-structured interviews. Informants included a hospital manager, a department head, a division chief and a frontline physician. The main reason for focusing on these staff was to ensure that the implementation process could be understood from different perspectives to provide a balanced and holistic account. The questions related to CP implementation processes and physician views on the program. The second interview round was conducted in March 2014. Eight interviewees included administrative staff and physicians. Efforts were made to verify the information collected in the first round while exploring new themes. The transcripts were checked immediately after each interview to resolve ambiguities. Transcribed data were coded thematically and analyzed to discover emerging patterns, trends and themes. Every informant gave verbal consent before and after the interview. The process was supplemented by a participant information sheet about the research aims, interviewee rights, including confidentiality and freedom to withdraw at any point.

Empirical results

Quantitative results

We conducted a descriptive analysis on the changes in the utilization and costs for the conditions entering the CP from 2010 to 2012. We then employed various regression analyses, controlling for individual factors, to model the patterns in year-to-year changes regarding LoS and medical costs for CP and non-CP patients, respectively. Table III compares the utilization and costs annual changes for patients entering the CP program from 2010 to 2012. Six diseases, for which data were available, including coronary artery disease (CAD), Caesarean section, uterine fibroids, myocardial infarction, acute appendicitis and senile cataract were selected for the CP program. When the program had just been implemented (2010 to 2011), the average LoS was significantly less for CAD, uterine fibroids and senile cataract patients; from 2011 to 2012, the program's second year, LoS had only decreased for CAD and Caesarean section. Medical costs decreased for myocardial infarction and acute appendicitis during the first year and most cost variables increased dramatically in the second year, which suggests the CP program's limited impact in cost containment, especially in the second year.

Table III here

For diagnoses that did not enter the program, average LoS also decreased from 2010 to 2011. However, all cost variables experienced an increase from 2010 to 2011 and they continued to rise from 2011 to 2012 (Table IV).

Table IV here

Table V shows the CP and non-CP patient regression analyses. Regarding LoS, holding all other factors constant, a significant decrease was observed from 2010 to 2011 for patients receiving CP treatments, but no significant trend was observed from 2011 to 2012. For patients receiving non-CP treatments, average LOS decreased by approximately 9% from 2010 to 2011 and increased from 34.8% in 2011 to 37.5% in 2012. Total costs also increased by 18.4% from 2010 to 2012. Regression results confirmed the descriptive analysis that the program had a limited impact on controlling costs and such an impact weakened in the second year.

Table V here

Qualitative analysis

The experimenting with CPs mandate was passed down the health system hierarchy, following MOH guidance in 2009. Hospital A, as a major tertiary hospital in the city, was, unsurprisingly, selected by the municipal health bureau for the pilot. In response to central guidelines, managers set up executive and assessment committees as required by the MOH to execute the pilot. Despite its participation, two main structural barriers were found to impede the implementation. The first, at the hospital level, was that were passively participating in the pilot program, giving reasons such as: "mainly because the government requires us to do so". However, implementing CPs may harm hospital drug and service revenues, which are a main income as noted by a hospital manager:

> We understand that the program can contribute to standardizing care, but at the same time, CPs have imposed considerable restrictions on the use of drugs, tests and procedures. However, they are exactly the key sources of our income. Implementing CPs essentially means we are losing profits. Look, I have the salaries and bonuses of more than 2,000 employees to account for. I also have an ambitious plan of infrastructural expansion and equipment procurement which all need money. If I tell you that I follow the cost containment instructions faithfully, that would be cheating you. (Dr. N, Hospital manager)

Although there were only a few diseases included in the pilot, they are all common and constitute mostly inpatient cases. To hospital managers preoccupied with holding the bottom-line, reducing LOS and average inpatient costs virtually means losing income. Clinical departments are trapped in the same situation because most Chinese public hospital managers divide their revenue targets internally and the targets in practice are constraining (He and Qian, 2013). For those forced to do so, progress has been sluggish as the Hospital A department head explained:

> CPs are not a compatible component for the current healthcare system or for our hospital. In our hospital, every medical department has a revenue target (from selling drugs and providing medical services), so implementing CPs will have a negative impact on our department target because under CPs we do not have the same autonomy of prescribing. We are reluctant to implement CPs. (Dr. L, Department head)

The second barrier is at the doctor level. Implementing CPs harmed hospital revenues and affected doctors' bonuses, which are based on drugs and services prescribed. In Hospital A, the performance-based bonus accounts for around 70% of doctors' incomes. As bonuses are

tied to physician performance in revenue generation, reducing costs means that their bonuses are affected. As one physician put it: "we are not motivated to do it and CPs are generally not well practiced in our hospital." (Dr. C, Ophthalmologist). Physician reluctance is also explained by CPs standardizing clinical protocols; essentially imposing restrictions on their practices, especially in prescribing drugs and tests. It is widely known that Chinese physicians take drug commissions from pharmaceutical companies, which then forms a substantial proportion of their incomes. To increase revenues, some staff also offer test-kickbacks to physicians whose profitable diagnostic tests, such as MRI and CT scanning lead to cash rewards. Compared to the situation before the CP program was implemented, physicians now have less discretion when prescribing, which in turn affects their incomes. A Hospital A physician remarked as follows:

> Implementing CPs also means being restricted in prescribing; this would affect my performance and also my salary. Performance evaluation is still based on service volume and revenue generation. My salary is not very high, and now it will be further affected by CPs. (Dr. Z, Gynecologist)

Hospital managers are aware that physicians lack incentive to implement CPs, but in the meantime, they face the administrative pressure from the health bureau to undertake the pilot. Hospital A staff, in 2010, chose to offer frontline physicians a financial incentive (RMB50 for each CP entry) to offset physician financial losses and seek their cooperation. The effect was immediate and remarkable. Physicians gained essential motivation to increase CP entries. Having found that the CP entry rates had been stabilized, hospital managers decided to withdraw the financial incentive in 2011. Unsurprisingly, physicians less actively enrolled CP cases, as noted:

> When there was an extra bonus with each enrollment, doctors were relatively supportive. When the financial incentive stopped, nobody was interested anymore. (Dr. W, Pediatrician)

> Doctors' salaries are linked with how many drugs they prescribed and services they provided. When there is no monetary incentive any more, nobody is motivated to enroll patients in the programme. (Dr. Z, Obstetrician)

Apparently, implementing CPs encountered challenges in Hospital A. The main problem was that cost containment conflicted with provider incentives. Hospital A managers relied heavily on revenues generated from drug prescription and services for financial survival, whereas CPs regulated drugs and services. These incentives were also translated to frontline doctors who were reluctant to undertake the pilot when their bonus incomes were affected.

Discussion and conclusion

Clinical pathways are document-based tools that provide a link between best available evidence and clinical practice. Our study demonstrated some compelling new evidence from CP program implementation in a northern China tertiary hospital. We found that the main objectives (standardizing treatment procedures by reducing LoS and containing costs) were not fully achieved. Furthermore, implementing CPs clearly encountered institutional barriers. The hospital managers did not see CPs as useful instruments and were still being driven by revenue generation. Physicians, too, lacked the full incentive to follow the guidelines due to income concerns. The high-powered incentives, especially revenue targets and bonuses,

largely offset CP potential effects in Hospital A. It was difficult to compare our findings with other studies, because previous research demonstrated heterogeneity in study design, methods and consequently results. A 2010 Cochrane review (27 studies and 11,398 participants) found a reduction in in-hospital complications and improved documentation associated with CPs, most studies in the review reported a decreased LoS and a reduction in the hospital costs after the CPs were introduced. Furthermore, considerable variation in the study design and settings also prevented pooling LoS and hospital costs (Rotter *et al*., 2010).

A nationwide assessment in CP pilot hospitals between 2010 and 2011 indicated that 90% of inpatients with the diseases experienced reduced LoS while the average costs dropped accordingly (Jiao *et al*., 2013), others found that the CPs had no or little effect on LOS and hospital costs; e.g., the Ji *et al*., (2005) case study in Zhejiang revealed that 30% of department heads in a pilot hospital refused to implement the CPs because it harmed hospital revenues. Our results also suggest that the CPs do not reduce LoS or contain hospital costs and that the pilot implementation encountered numerous structural barriers. We found that CP effectiveness was undermined by countervailing incentives that formed an institutional environment unconducive to cost containment efforts, such as CPs, which rely on well-aligned incentives, especially scientific payment mechanisms. In China's case, the current health system is still functioning as a FFS. To generate enough revenue, most hospital managers have established incentives to encourage prescribing and medical services beyond what is required (Yang and Wu, 2014). Doctor salaries are tightly bound to their individual medical department's performance. The more revenue department staff generate, the larger the bonuses received by doctors.

System-wide incentives, especially under-subsidized health providers who are over-relying on providing medical care and drug sales to survive, have been identified as a fundamental cause for over-prescription, medical impoverishment and unaffordable access. The policy makers have to bear in mind that CPs alone will not be able to fully contain costs because hospital managers are not constrained to a hard budget. It is essential to change the provider payment incentives and this may require thorough hospital sector reform. If the FFS system seems impossible to change then it is important to consider strategies to alter the perverse incentive embedded in the FFS payment system. Prospective payment methods are suggested and have already been used to make providers bear the overprescribing financial risk and to provide incentives for providers to reduce inefficient services. Evidence has begun to emerge, pointing to positive effects from using prospective payment methods to regulate provider behaviours in China (Luo, 2011, Jiao *et al*., 2013). Lastly, the policy makers should also establish appropriate service-specific standards regarding services to be delivered, closely monitor provider performance and enforce those standards.

When contemplating policy implications, we must also bear the study's limitations in mind. Although we provided more refined descriptive and regression analyses to capture the association between CP program, LoS and hospital costs, the results can only be interpreted as correlation rather than causality. Determining a causal relationship between CPs, LoS and hospital costs is more complex and may require establishing a control group or using longitudinal data. Furthermore, it would also be interesting to examine other CP outcome indicators, such as service quality and patient outcomes. Another limitation is the study's generalizability. Any generalization to a wider context should be cautious.

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Table I: Stay and hospital costs from primary CP studies in China, published since 2009

Study	Province	Facility	Time	Disease	Sample	Outcome				
						LOS	Total inpatient costs	Drug costs	Test costs	Treatment costs
Liu *et al*., 2012	Anhui	Single hospital	Oct 2008-Nov 2011	Type 1 Diabetes Mellitus	Before:22	10.6±9.7	9386±11330	3467±4974	1848±1767	1491±1535
					After:38	9.9±4.6	6284±4447	2641±2428	1510±1473	1402±909
Ma *et al*., 2013	Gansu	Single hospital	Jan 2008-Aug 2012	23 diseases	Before:1436	11.4±5.6	6668±3503	3495±2883	*Not reported*	
					After:1445	6.4±2.8	5798±3046	2643±2180		
Lang *et al*., 2010	Shanghai	Single hospital	Apr 2008-Apr 2009	Intracranial aneurysms	Before:45	18.1±4.7	88k±23k	*Not reported*		
					After:45	15.3±2.7	70k±21k			
Deng *et al*., 2013	Not specified	Five hospitals	Mar 2011-Oct 2012	Transient ischemic attack	Comparison:225	13.2±4.7	10585±5161	4479±2210	*Not reported*	
					Treatment:202	9.9±4.3	9200±4624	3834±2280		
Wang *et al*., 2013a	Beijing	Single hospital	2005 & 2010	Knee replacement	2005:164	23.6	66422	7309	3673	16424
					2010:471	9.5	57862	4710	2967	9935
Wu *et al*., 2012	Beijing	Single hospital	Jan 2010-Dec 2011	Acute myocardial infarction	Before:190	17.1±12.5	58151±39381	*Not reported*		
					After:228	11.2±6.2	49870±39211			
				Acute heart failure	Before:194	17.0±10.8	58151±39381			
					After:204	15.1±11.4	49870±39211			
				Community acquired pneumonia	Before:296	18.2±7.8	33134±35304			
					After:362	15.7±7.5	26284±24185			
				Cerebral infarction	Before:80	26.0±25.4	15348±7300			
					After:140	20.5±13.8	12892±7719			
				Hip replacement	Before:33	29.1±15.7	48711±20586			
					After:58	23.7±10.0	37955±14220			
				Coronary artery bypass grafting	Before:39	31.5±13.4	94786±20955			
					After:59	24.5±6.7	85284±24185			
Zhang and Dong, 2014	Henan	Single hospital	Unknown-Jun 2011	Capillary bronchitis	Before:98	15.5±6.7	3099±125	1978±99	*Not reported*	
					After:93	9.5±4.7	1679±104	897±77		
Chen *et al*., 2013	Jiangsu	Single hospital	Jun 2009-Dec 2010	Inguinal hernia	Before:31	8.0±6.0	8244±5152	2737±2630	*Not reported*	
					After:31	6.0±3.0	7051±2168	1687±1626		
				Cataract	Before:51	5.0±3.0	6582±2369	718±319		
					After:49	5.0±1.0	6524±1883	198±299		
				Premature rupture of membranes	Before:262	4.0±1.0	3551±1384	479±796		
					After:348	4.0±1.0	3027±1001	172±75		

				Lower limb varices	Before:42	7.0±2.0	8771±1820	4725±1124		
					After:23	7.0±1.0	8764±1686	4237±1058		
				Vocal polyps/nodules	Before:53	8.0±2.0	5289±1438	1954±919		
					After:43	7.0±3.0	6822±1142	2654±972		
Li and Fu, 2014	Hubei	Single hospital	Dec 2010-Dec 2012	Cataract	Comparison:200	10.2±0.1	4827±132	1206±54	850±24	*Not reported*
					Treatment:200	6.0±0.1	4401±129	720±23	700±46	
Wang and Lin, 2012	Zhejiang	Single hospital	Jan 2009-Jun 2011	Acute appendicitis	Comparison:79	6.7±6.0	5457±2504	*Not reported*		
					Treatment:186	5.9±4.0	6296±3063			
				Nodular goiter	Comparison:363	9.5±9.0	9198±2285			
					Treatment:258	7.3±7.0	8613±2312			
				Cataract	Comparison:122	5.3±5.0	9429±7196			
					Treatment:407	4.9±4.0	6715±2911			
Gao *et al*., 2010	Shandong	Single hospital	Jan 2009-Oct 2009	Inguinal hernia	Comparison:80	6.5±0.7	4284±674	*Not reported*		
					Treatment:80	2.3±0.6	2319±439			
Wang and Gong, 2013	Hubei	Single hospital	Jan 2010-Dec 2011	Transient ischemic attack	Before:60	10.6±4.0	3975±2932	*Not reported*		
					After:60	8.6±4.2	5608±3200			
Zeng *et al*., 2013	Guangdong	Single hospital	2008 & 2011	Vocal polyps/nodules	Before: 273	5.4±1.5	5447±454	1213±297	*Not reported*	2819±105
					After: 416	4.5±1.8	5324±605	931±261		2776±313
				Multinodular goiter	Before: 372	7.0±1.3	6712±463	778±313		3335±384
					After: 821	6.3±1.7	6975±1138	626±207		3446±653
				Community acquired pneumonia	Before: 334	9.9±4.2	6455±2785	2940±1419		*Not reported*
					After: 245	8.5±2.5	6104±2141	2372±1169		

Table II: CP and non-CP patient characteristics

	CP			Non-CP		
	2010	2011	2012	2010	2011	2012
N	293	622	424	9,943	15,812	11,626
Age	57.43	57.32	58.93	54.45	54.99	55.77
Male	66.89%	69.45%	58.73%	57.27%	59.91%	50.76%

Table III: CP utilization and costs by disease type (2010 to 2012)

Disease types	Year	*N*	LOS	% change	Total cost	% change	Drug cost	% change	Examination cost	% change	Cost per day	% change
Coronary artery disease	2010	49	18.12		8,495.01		3,180.01		1,651.16		751.76	
	2011	111	10.95	-39.60%	7,875.39	-7.29%	3,465.03	8.96%	1,476.19	-10.60%	1,157.39	53.96%
	2012	87	9.41	-14.00%	8,788.19	11.59%	4,127.98	19.13%	1,778.21	20.46%	1,404.63	21.36%
Caesarean	2010	47	7.44		4,942.72		794.64		273.59		674.77	
	2011	56	8.04	8.02%	5,269.92	6.62%	1,308.20	64.63%	381.51	39.45%	675.25	0.07%
	2012	35	7.23	-10.04%	5,422.15	2.89%	1,684.17	28.74%	438.17	14.85%	774.66	14.72%
Uterine fibroids	2010	34	12.91		5,791.91		1,524.63		418.50		561.07	
	2011	93	11.32	-12.31%	6,340.21	9.47%	1,540.92	1.07%	521.37	24.58%	641.30	14.30%
	2012	50	11.22	-0.91%	7,786.74	22.82%	2,370.89	53.86%	730.78	40.17%	753.78	17.54%
Myocardial infarction	2010	32	8.56		13,095.36		3,412.28		2,624.16		1,877.41	
	2011	80	8.89	3.80%	12,515.95	-4.42%	4,917.47	44.11%	2,568.84	-2.11%	1,700.17	-9.44%
	2012	57	10.05	13.11%	16,139.60	28.95%	6,917.73	40.68%	2,915.45	13.49%	1,698.79	-0.08%
Acute appendicitis	2010	44	7.36		5,950.23		2,072.29		298.07		807.49	
	2011	55	7.40	0.49%	5,502.74	-7.52%	2,555.99	23.34%	755.81	153.57%	759.35	-5.96%
	2012	41	7.39	-0.13%	6,787.15	23.34%	3,507.32	37.22%	1,090.45	44.28%	1,103.31	45.30%
Senile cataract	2010	65	7.78		4,876.16		787.70		668.55		699.90	
	2011	184	7.52	-3.38%	4,933.61	1.18%	1,051.36	33.47%	713.02	6.65%	709.48	1.37%
	2012	117	8.59	14.20%	6,433.89	30.41%	1,891.72	79.93%	1,035.36	45.21%	826.62	16.51%

Table IV: Change of utilisation and costs from 2010 to 2012 (including diagnoses not entering CP programme)

Year	N	LoS	% change	Total cost	% change	Drug cost	% change	Examination cost	% change	Cost per day	% change
2010	9,943	14.96		9,114.49		3,065.39		1,079.79		759.97	
2011	15,812	13.76	-0.08	9,585.36	0.05	45,49.46	0.48	1,485.98	0.38	911.48	0.20
2012	11,626	14.75	0.07	11,595.53	0.21	5,845.46	0.28	1,791.89	0.21	1,006.78	0.10

Table V: CP and non-CP patient regression results

	CP					Non-CP				
	LOS		**Total cost**	**Drug cost**	**Cost per day**	**LOS**		**Total cost**	**Drug cost**	**Cost per day**
	Poisson	**Negbin**	**OLS**	**OLS**	**OLS**	**Poisson**	**Negbin**	**OLS**	**OLS**	**OLS**
Age	-0.0009	0.0009	.0229***	0.0139	.0302***	.0285***	.0348***	.0498***	.0923***	.0151***
Age2	0.0001	0.0000	-.00018**	-0.0002	-.00027***	-.00025***	-.0003***	-.00033***	-.0006***	-7.3e-05***
Gender	-0.0071	0.0070	-.155***	-.363***	-.202***	-.33***	-.34***	-.205***	-.429***	-.0193**
Marital Status	.206*	0.1890	0.1920	0.3050	-0.1080	-.466***	-.541***	-.396***	-1.06***	0.0243
Job1	-0.0319	-0.0165	-0.1440	.	-0.0839	-.372***	-.341***	-0.0284	-0.7930	.136*
Job2	.151*	0.1530	-0.0416	0.3180	-0.1500	.0643***	.0762***	-0.0145	-1.0100	-0.0050
2011	-.143***	-.137**	-0.0319	-0.1270	0.0588	-.0933***	-.0923***	0.0139	.0735***	.0907***
2012	0.0160	0.0076	0.2110	0.4750	0.1480	.376***	.348***	.184**	0.0923	0.1030
Constant	1.85***	1.81***	7.97***	6.76***	6.22***	2.57***	2.44***	7.68***	6.89***	5.84***
	-15.1500	-8.6000	-38.8700	-11.7400	-32.8400	-201.9100	-62.6100	-204.1200	-7.9300	-177.6500
lnalpha Constant		-1.36***					-.628***			
N	1338.00	1338.00	1338.00	1338.00	1338.00	37347.00	37347.00	37347.00	37347.00	37347.00
ll	-5025.00	-4067.00	-1236.00	-1995.00	-1129.00	-290000.00	-130000.00	-42410.00	-55477.00	-37328.00
r2_p	0.02	0.01				0.04	0.01			

chi2	195.00	53.90				22347.00	2672.00				
r2			0.05	0.04	0.08			0.16	0.20	0.06	

Figure 1: CPs in Chinese public hospitals (Adapted from Wang *et al*., (2013b)